ACCEPTABILITY OF ECONOMIC INSTRUMENTS FOR IMPROVING THE MANAGEMENT OF PLASTIC BOTTLED WATER SCRAP IN ENUGU URBAN

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Abstract— This paper appraised the acceptability of Deposit Refund System (DRS) under an Extended Producer Responsibility (DRS-EPR) for improving the management of PET bottled water scrap (PBWS) in Enugu Urban. It explored how DRS and EPR have been significant in managing plastic drink wastes while generating revenue in several parts of the world and how it can be applied to improve the management of PET bottled water scrap (PBWS) while generating revenue. The Objectives were to develop an acceptable course of Deposit Refund System under an Extended Producer Responsibility for improving the management of plastic bottled water scrap in Enugu Urban and to determine the extent of acceptance of the developed course of Deposit Refund System under an Extended Producer Responsibility for improving the management of plastic bottled water in Enugu Urban. A hypothetical DRS-EPR course for improving the management of PBWS was designed and sensitized to 848 randomly sampled respondents from randomly sampled layouts based on the Bid Rent Urbanization theory after which questionnaires were distributed to them to evaluate the extent of agreement of each step in the flow on a 7 point likert scale from completely disagree to completely agree. A reliability test using Cronbach Alpha gave a value of .854 for the 39 items indicating the reliability of the sample and sufficiency of item for each factor. There was significant agreement of the developed course of DRS-EPR for improving the management of plastic bottled water scrap in Enugu Urban (KMO and Bartlett's Test of assumption 0.819 and 0). Principal Component Analysis (PCA) was used to empirically determine and measure the magnitude of acceptance of the developed course of DRS-EPR for PBWS. The result showed high communalities (.40>) with Twelve factors having eigenvalues greater than 1.0 with a cumulative percentage of variance of 65.620. The orthogonal rotated varimax matrix inferred 10 component factors; Component 1 –Benefits, Component 2- Recommendations; Component 3- Strategy for handling of Deposits; Component 4- Collection of Deposits; Component 5- Strategy to checkmate free fliers amongst others The study therefore, recommends for the consideration of the developed flow for DRS-EPR in the current policy framework for managing PBWS in Enugu Urban.

Index Terms— Deposit Refund System (DRS), Economic Instruments (EI) Enugu, Enugu State Waste Management Agency (ESWAMA), Extended Producer Responsibility (EPR), , PET Bottled Water Scrap (PBWS), Urban

1.0 Introduction

Solid waste management has emerged as one of the greatest challenges facing state and local government environmental protection agencies in most developing countries. The volume of solid waste being generated in these countries continues to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth (World Watch Institute, 2015). These perennial constraints widen the gap between waste management policy, legislation and actual waste management practices. Yet, waste generation is expected to increase significantly as a result of industrialization, urbanization and modernization of agriculture with positive correlation to negative externalities of environmental impact.

The estimated quantity of Municipal Solid Waste (MSW) generated worldwide is 1.7 – 1.9 billion metric tons (United Nations Environment Programme, UNEP, 2009) and it's expected to jump to 3.4 billion tons over the next 30 years (Waste 360, 2018). In many cases, municipal wastes are not well managed in developing countries, as cities and municipalities cannot cope with the accelerated pace of waste production.

Plastic consumption has increased with poor waste management and sanitation practices. Global annual consumption of plastic material has increased from around 5 million tonnes in the 1950's to nearly 299 million tonnes in 2013 (Worldwatch Institute, 2015) and constituted 12 per cent of all solid wastes in 2018 (Waste 360, 2018); thus, almost 60 times more plastics is produced today than 50 years ago. This indicates that more resources are being used to meet the increased demand for plastics and consequently, more plastic wastes are being generated (Worldwatch Institute, 2015).

In Nigeria, plastic consumption increases at a rate of 13.9 per cent per annum with plastic packaging especially Polypropylene and Polyethylene Terephthalate (*PET*) accounting for 53.8 per cent amongst other plastic uses (EuroMap, 2017). These PET plastics are in very high demand for selling of palm and groundnut oil, and drinks such as Sogbo, Kunu, tiger nut drink, water bottles for school children, production of bags, pipes, furniture and kitchen utensils (Abaje and Giwa, 2005). The badly damaged ones are often times indiscriminately littered thereby blocking river channels, drains and strategic flood routes, (Abaje and Giwa, 2005) or even worse, end up in landfills for incineration and emitting significantly more greenhouse gases (Global Alliance for Incinerator Alternative, 2013) and toxic chemicals which are synthetic carcinogens into the environment (Inter America Development Bank, 2003; Fujan, 2015).

In developed countries, remarkable progress has been made in waste management strategies by adopting a policy principle to promote total life-cycle environmental improvements of product systems; extending the responsibilities of the manufacturer of the product to various parts of the entire life-cycle of the product (Lindhqvist, 1999; Zhong, 2012). This policy principle is termed Extended Producer Responsibility (EPR). The EPR policy devices economic instrument tools to prevent and manage wastes by internalizing environmental or depletion cost through a change in the incentive structure; one of these economic instrument tools that have been successfully used is the Deposit Refund System (DRS).

In Europe, deposit-refund systems on beverage containers combined with product charges on non-reusable containers have been operating successfully. In Finland, Norway, and Sweden the percentage of drink package scrap returned is 90 per cent (Panayoutou, 1994). This success propelled several European countries to extend the system to other products such as batteries, car hulks, and pesticide residues.

The United States and Canada have also used the DRS with significant results. As of mid-2011, ten states in North America and eight Canadian provinces had some kind of bottle bill with no resultant

increase in inflation (Walls, 2011). In some Asian countries, DRS stimulated product innovation and environment-friendly design by manufacturers in reducing materials, resources and energy usage, extending the useful life cycle of products, increasing opportunities for recovery and re-use of the product at end of- life (Scott and Thomson, 2007).

Enugu urban has witnessed cumulative increase in population by 34.5 per cent from the year 2009 to 2014 (Uwadiegwu, 2014) and consequent increase in municipal solid waste. Plastic bottled water is one of the predominate packages seen in Enugu Urban. The scraps are either picked up by scavengers and re-sold for unhygienic re-use or disposed illicitly and indiscriminately with consequent costly implications. Enugu State Waste Management Agency (ESWAMA) has invested millions of naira and adopted command and control instruments in managing these waste. Yet, the volume and characteristics of the waste especially plastics continue to increase faster than the ability of the agency to improve on the financial and technical resources needed to manage this growth (Eneh and Anamalu, 2012; Enugu State Vision 2020, 2014; Agunwamba, Agunwamba. Asogwa,, Ugwuanyi, Samuel, Chijioke and Adibe, 2014; Iyida, 2015). Scholars (Abaje and Giwa, 2005; Iriruaga, 2015; Ikebude, 2017) assert that plastic scraps constitute a large proportion of municipal solid waste in Nigerian cities. Plastic scraps are problematic and if not well managed properly, they will constitute health hazards and contaminate water ways and ecosystems in Enugu Urban for thousands of years. It is therefore against this background that this study aims to appraise the acceptability of Deposit Refund System under an Extended Producer Responsibility for improving the management of plastic bottled water scraps (PBWS).

2.0 Literature Review

According to Wall (2011), deposit-refund system is compatible with the EPR concept and has taken hold in many countries with different adopted versions of DRS. The author went further to say that in many versions of DRS-EPR, an up-front fee is assessed on product sales and the proceeds are then used to fund collection and recycling programs. This is, in fact, how the German system works. Most producers do not physically collect materials themselves, but rather belong to a producer responsibility organization that assumes responsibility for collection and recycling and covers the cost of the service through member company fees. In support of Wall's (2011) statement, Nashfa (2016), pointed out that in most economically developed countries, producers belong to a Producer Responsibility Organisation (PRO). These PRO's assume responsibility for collection and recycling, and cover the cost of the service through member company fees, which among others, can depend upon per weight of material and material type (Walls, 2011; Kunz *et al*., 2014).

Furthermore, according to Kunz *et al*, (2014), PRO's were created to facilitate an efficient collection and recycling scheme, and they are oftentimes collectively owned by breweries, importers, or retailers, to organise and administer the collection and recycling of waste on behalf of producers. There are also other approaches where governments charge fees or taxes to producers and pay for waste collection and recycling as with Taiwan, Korea, and Hungary.

In addition, Kim (2004) explored the introduction of the DRS-EPR in Taiwan. He noticed that since the implementation (DRS) and new responsibilities (EPR) allocated to producers, Taiwanese producers are starting to clearly understand the link between their products and their impact on society and the environment. Therefore, wide implementation of mandatory deposit-refund systems stimulates producers to improve their product design and the environmental–friendliness of their products, including packages. However, Kim (2004) stressed the limitations and challenges from the introduction of the system: first, they faced a deficit in the deposit-refund fund caused by failure to control unregistered producers and failure to establish a controlling measure (to distinguish PET bottles with advanced payment of deposit fee and those without). To solve this problem, western and Nordic countries use bar codes to disallow PET bottles outside of their own systems and pay the refund of the deposit for the accepted bottles (Kim, 2004; Hogg *et al*, 2010; and Fletcher *et al*, 2012).

Another challenge hinted by Kunz, Atasu, Mayers, and Van Wassenhove (2014) in implementing EPR for waste collection is the complexity of waste collection. The scholars identified five factors that limit or disrupt the stability and effectiveness of EPR system: Commodity dynamics- the waste value or cost; Volume dynamics - waste availability to EPR system as: Competition dynamics - level of competition between PRO's as well as waste operators; Regulatory dynamics - new regulatory requirements; and Design dynamics -development of new products by producers.

Kunz *et al* (2014) however made the following recommendations for EPR to achieve its environmental objectives more effectively and efficiently as thus: for Commodity dynamics, PRO's should act as waste brokers and waste operators should only process waste and not speculate; for volume dynamics, recycling standards should be imposed on all flows; for Competition dynamics, National authorities should open market to competition; in Product dynamics, incentives for recyclability should be coordinated at the highest level of authority in order to have stronger impact on producers; and for regulatory complexity, the highest authority should have general binding principles on EPR but national regulatory framework should remain flexible to adapt to the market.

Integrating DRS and EPR for package waste management has shown high effectiveness in recent time. In Finland, in 2015 the return rate for aluminium cans was at the level of 95 per cent, for plastic bottles – 92 per cent, for recyclable glass bottles – 89 per cent, and 98 per cent return rate was registered for the refillable glass bottles (Palpa, 2016). In general, it is estimated, that Finnish customers return nearly 1.7 billion beverage containers every year (Kalinovskaya, 2016). According to PALPA – the company responsible for DRS for one-way containers, recycling of beverage containers produces nearly 17,000 tonnes of aluminium, 13,000 tonnes of PET and 50,000 tonnes of recyclable glass annually (Helsinki Times, 2016).

According to Kalinovskaya (2016), in Lithuania, DRS for one-way beverage containers began to function in February 2016. Prior to the system's implementation, the rates for plastic packaging collection were at the level of 17 per cent, and for metal – 8.5 per cent (Deposit System Administrator, 2016). It was assumed that approximately 55 per cent of all one-way beverage containers will be processed by the system during the first year of its launching, which accounts for more than 300 million items collected and recycled. Yet, as of August 2016 (after 7 months of system being in place), the results were much higher than expected: the calculator for the packaging collected shows more than 200 million of items already. In the future, the levels achieved are expected to be even higher (Deposit System Administrator, 2016).

Kalinovskaya, (2016) discovered that one of the major factors for the success of DRS in Finland and Lithuania is the addition of the EPR scheme. According to the author, the mix of EPR and DRS helped to address two issues: avoid trade barriers associated with mandatory DRS and still collect money through EPR to finance DRS.

In the Nigerian perspective, scavengers are important stakeholders that have not been captured in the above concept flow for a DRS. Thus; a DRS-EPR hypothetical flow was designed incorporating scavengers. In the designed frame-work in figure 1 below, Producers of PET bottled water place deposits per unit on bar-coded products into the market. Retailers/wholesalers purchase PBWS with the deposits and sale drinks with deposits to consumers. Consumers buy PBWS with deposits and return empties back to retailers and get 50 per cent of the deposits refunded or lose refund to ESWAMA and Scavengers if not returned. Enugu State Waste Management Authority sends PBWS from general waste stream to Producer Responsibility Organization (PRO) and receives refund on only bar-coded PBWS. Those picked by scavengers will also be returned to the PRO and receive refund on only barcoded PBWS. PBWS returned by consumers to retailers and wholesalers will be returned back to producers and 50 per cent of Deposits refunded. These returned PBWS will be carried back by the same transport that brings the supply of packaged drinks. Rather than leaving empty, they go back with the empty PBWS.

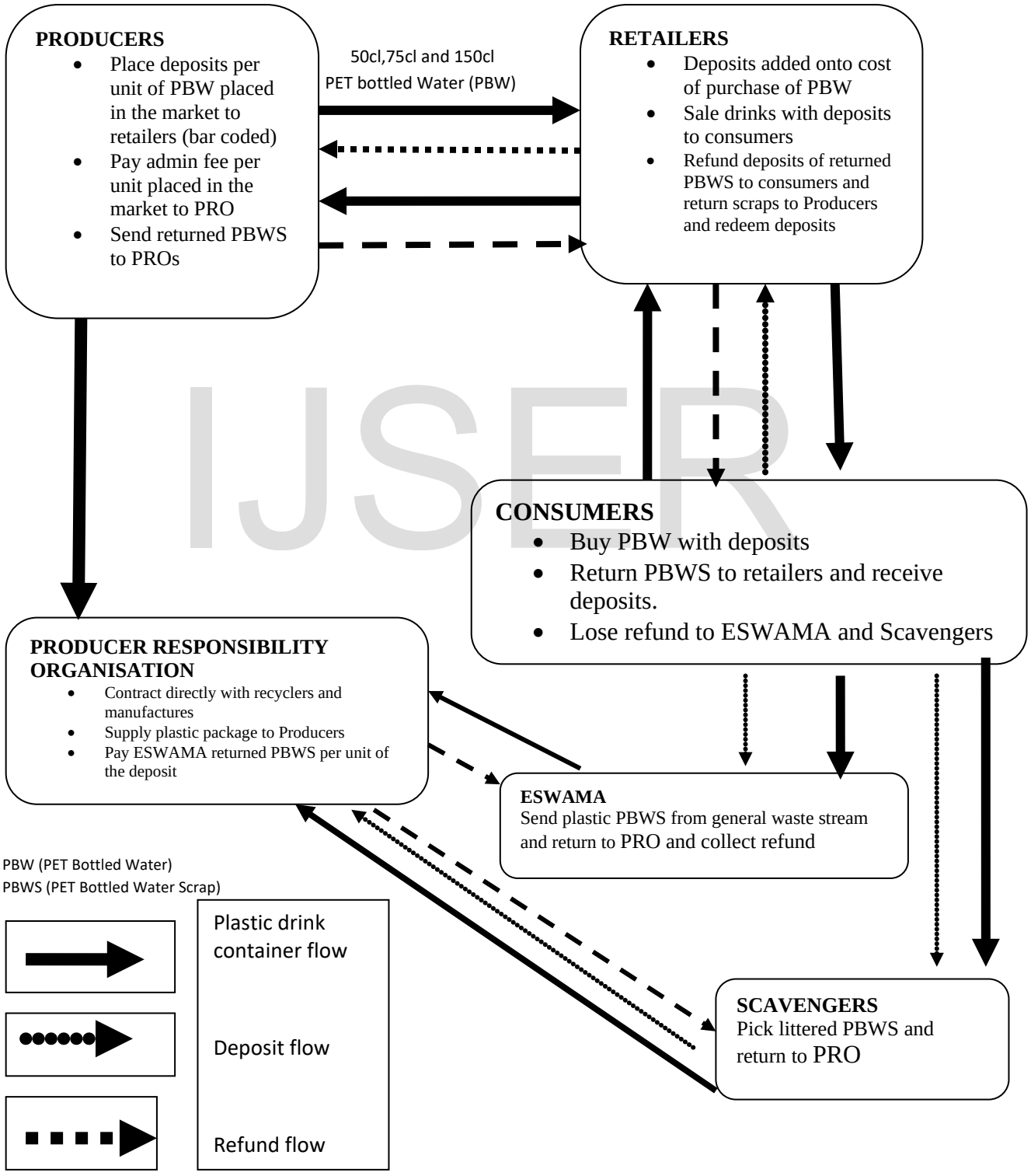
PRODUCERS
Place deposits per unit of PBW placed in the market to retailers (bar coded)
Pay admin fee per unit placed in the market to PRO
Send returned PBWS to PROs
50cl,75cl and 150cl
PET bottled Water (PBW)
RETAILERS
Deposits added onto cost of purchase of PBW
Sale drinks with deposits to consumers
Refund deposits of returned PBWS to consumers and return scraps to Producers and redeem deposits
CONSUMERS
Buy PBW with deposits
Return PBWS to retailers and receive deposits.
Lose refund to ESWAMA and Scavengers
PRODUCER RESPONSIBILITY ORGANISATION
Contract directly with recyclers and manufactures
Supply plastic package to Producers
Pay ESWAMA returned PBWS per unit of the deposit
ESWAMA
Send plastic PBWS from general waste stream and return to PRO and collect refund
SCAVENGERS
Pick littered PBWS and return to PRO
PBW (PET Bottled Water)
PBWS (PET Bottled Water Scrap)
Plastic drink container flow
Deposit flow
Refund flow

Figure 1: Hypothetical Material Flow for a Deposit Refund System Under An Extended Producer Responsibility For Enugu Metropolis.

3.0 Study Area

Enugu metropolis is located in Enugu State, Nigeria within latitudes 6°27′9.60″N and 6°27′9.60″N and longitudes 7°30′37.20″E and 7°30′37.20″E (Nnam, Maduako, Nnam Uchechukwu, and Chukwubueze, 2014). The city core has an area of about 90 km2 (Nnam et al, 2014) and comprises of three local government areas namely- Enugu East, Enugu North, and Enugu South (Enete and Alabi, 2012). The city shares boundary with Igbo Etiti and Isi-Uzo Local Governments in the north, Udi local Governments in the west, Nkanu West Local Government in the south and part of Nkanu East Local Government Area in the east (Figure 2). There are 23 prominent residential areas in the Metropolis. These are Abakpa, Trans-Ekulu, Nike, GRA, New GRA Ogui, Asata, New Heaven, New Haven Extension, Obiagu, Ogbete, Iva valley, Independence Layout, Achara Layout, Ugwuaji, Maryland, Awkwunanaw, Uwani, Agbani, Emene, Thinkers Corner, Federal Housing and Coal Camp.

The existence and evolution of Enugu urban assumes three theories of urbanization; the modern urbanization theory, spatial disparities theory and Bid rent theory (BRT). In conformity with the urbanization theory, Enugu was declared a second class city in 1917 after the development of the Coal Industry and subsequent survey of the Government Reserved Area (GRA) (European Quarters) and Coal Camp settlement (labourers' quarters) (Eze, 2009). It satisfies the concept of Spatial disparities due to its geographical advantage of its political importance as seat of government of the south eastern states. It also conforms with the Bid-Rent Theory because of the variation of the price of land from the Central Business District to the Periphery.

These theories inevitably explain the settlement pattern of Enugu Urban layouts (Figure 3.2) The evolution of the city from the city centre is commercialized (Ogbete Main market, commercial banks and zonal headquarters of administrative offices including ESWAMA, NESREA and Enugu Chamber of Commerce and industry, commanding high rental value with high density settlement (Ngenevu, Coal Camp, Obiagu and Asata) with pocket industries. This is followed by the mid and high density settlement extending southward of the city centre (Uwani, Achara layout, Akwunanaw, Idaw River and Gariki) and low density extending north - ward (GRA, Trans Ekulu and New GRA). East - ward from the city centre are low and mid density settlements (Independence layout and New Haven). At the periphery on the east

are mid density settlements with heavy industries (Emene Industrial layout and Emene residential settlements. Northward after the low density settlements are high density settlement with pocket industries and commercial hubs (Ugbene, Abakpa and Ibagwa).

Several drink manufacturing industries are located in Enugu to meet the existing consumer demand for PBW in the metropolis. This has caused strange variety and typology of PBWS in waste dumps and littered all around the streets within the study area with the gutters blocked causing flooding during the raining season. Also, the increase in population and consequent increase in the volume of PBWS increases faster than the ability of ESWAMA to manage the waste. Analyzing the cost efficiency of ESWAMA by Aguwamba et al (2014) the average total cost comprising the haul container system and the stationary container system is over 22 million naira per week with an average efficiency of 69.7 per cent. In spite of this expense, the waste management strategy practiced by the Government approved waste management agency in the area is so poor and inefficient that huge waste dumps are found in most available dump sites at every time and much volume of refuse are constantly found.

While ESWAMA is a legal body established by the Enugu State government for the management of wastes, scavengers are illicit pickers of general wastes. In the case of PET bottles, scavengers make routine visit on daily basis to legal and illegal waste dump sites (Chukwu, 2018), sit-outs and venues of festivities to collect PBWS. These scraps are transported to collection centres located at Okpara Avenue railway by subway, Jim Nwobodo Avenue, Trans-Ekulu; Nkpor street, Abakpa Nike, Edozie Street, Uwani (Nzeadibe, 2009) and; No. 1 Udoma street, New Haven. From a pilot survey, daily earning of this waste pickers is between N800 and N1,300 naira per day which is more that the government minimum wage of N18,000 per month. From an earlier survey by Nzeadibe (2009) middlemen in the scavenger business will earn higher since they re-sell the wastes in a larger scale to industrial recyclers in Onitsha and Lagos.

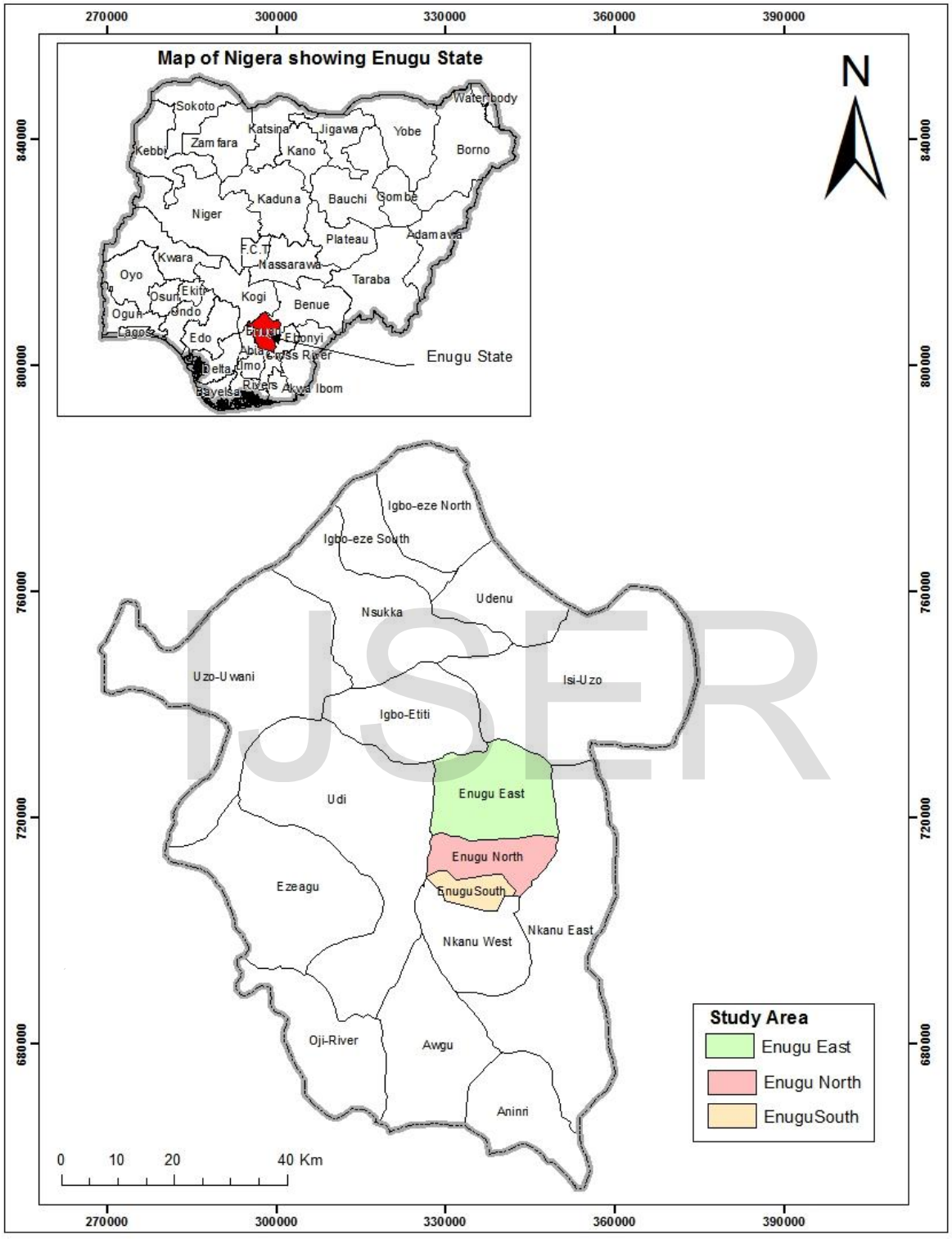

Figure 2: Map of Enugu State and local government Areas Showing the Study Area.
Source: Okwu-Delunzu, *et al*, 2015

Plate 5.1: Game bottled water section

Plate 5.2: Aqua Rapha Depot, Nise

Plate 5.3: Ivy Water Depot Ogui Junction

Plate 5.4: Shoprite shopping Mall

Plates 5.1-5.4 show PBWS in departmental shops, malls and depots in Enugu Urban. These sopping centers have daily delivery of PBWS from producers in and outside Enugu.

Plate 5.5: Scavenger at Subway, Ogbete

Plate5.6: Scavenger Picking Bottles at National museum

Plate 5.7: Scavengers' bails in Ugwuaji

Plate 5.8: Washed containers ready for sale

Plates 5.4- 5.8 Show scavengers in different parts of Enugu Urban gathering PBWS for sale to Palm and Groundnut Oil sellers and, Kunu and Zobo makers. In plate 5.8, one can see the dirty water used in cleaning the bottles for re-sale.

Plate 5.9: PBWS blocking drainage

Plate 5.10: PBWS blocking driveway after heavy down pour

5.11 Sectional View of Landfill at Ugwuaji

Plate 5.12: Open dumping of Plastics

Plates 5.9 – 5.16 shows the effect of PBWS in the environment ranging from drain blockage, flooding, soil degradation, contamination of ground water and air pollution.

Plate 5.13: Plastic Menace

Plate 5.14: PBWS blocking drainage

Plate 5.15: PBWS being removed from a blocked drain

Plate5.16 PBWS blocking drainage in Enugu

4.0 Methodology

The study adopted a survey design which entitled the use of questionnaire. A 39 itemed questionnaire was designed on a 7-point Likert scale from completely disagree (1) to completely agree (7). This was to collect data to measure the magnitude of acceptance of the developed hypothetical flow of DRS-EPR for improving the management of plastic drink package wastes in Enugu Urban. A sample size of 848 respondents was determined from the 2006 National Population Commission (NPC) Census Data projection of households in the three Local government areas that that make up Enugu Urban - Enugu North, Enugu South and Enugu East using the Michael Keenan model (2017). Stratified sampling was used to select respondents from the sample frame based on the concept of the Bid Rent Theory (BRT). This concept was used

because the variation of the price of land from three sectors is a determination factor of occupations and different levels of income represented by the Central Business District (CBD) (Ogui, Ogbete, Garden Avenue); light Industry /high density settlement (Coal Camp, New Haven, Uwani, GRA, Kenyatta, College Road, Achara layout) and; the Periphery (heavy Industry/ Low density settlement). Out of 848 copies of questionnaires that were administered to respondents, 676 copies representing 80 per cent were returned. A reliability test using Cronbach Alpha gave a consistency value of .854 for the 39 items indicating an acceptable internal consistency and sufficiency of item for each factor.

Principal Component Analysis (PCA) was used to test the research hypothesis which states that the developed course of Deposit Refund System under an Extended Producer Responsibility for improving the management of plastic bottled water scrap (PBWS) in Enugu Urban is not acceptable. The statistical technique converted the 39 factors used in the study to determine the acceptance of the developed course of DRS-EPR into a set of values of linearly uncorrelated variables called principal components using orthogonal rotated varimax matrix. The 39 factors and their factor loadings are shown in the PCA result in table 1.

5.0 Data analysis

5.1 Descriptive of Statistics of Respondents

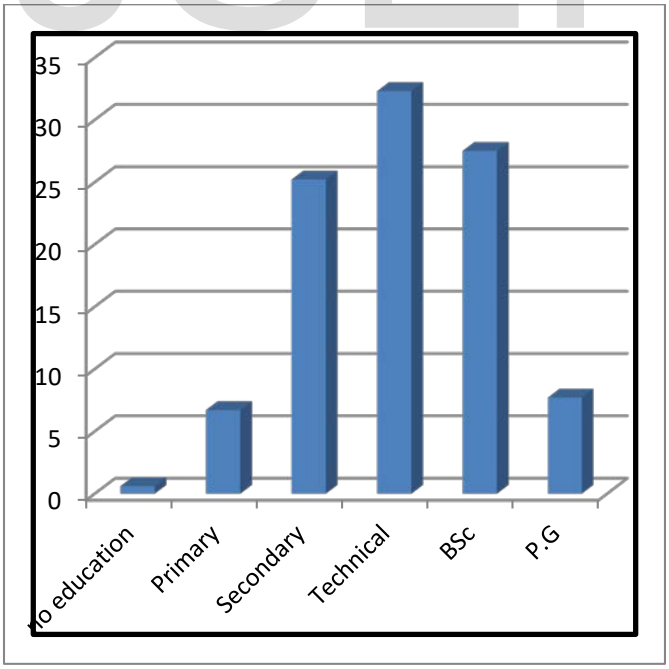

Figure 3: Educational level of Respondents

In the bar chart above, most of the respondents have technical education with 32.3 per cent followed by Bachelor of Science with 27.5 per cent and secondary education with 25.2 per cent. The least respondents are those with no education with 0.6 per cent. This implies that a cumulative of 66.8 per cent of respondents have tertiary education and are knowledgeable to understand the developed DRS-EPR course for managing PBWS.

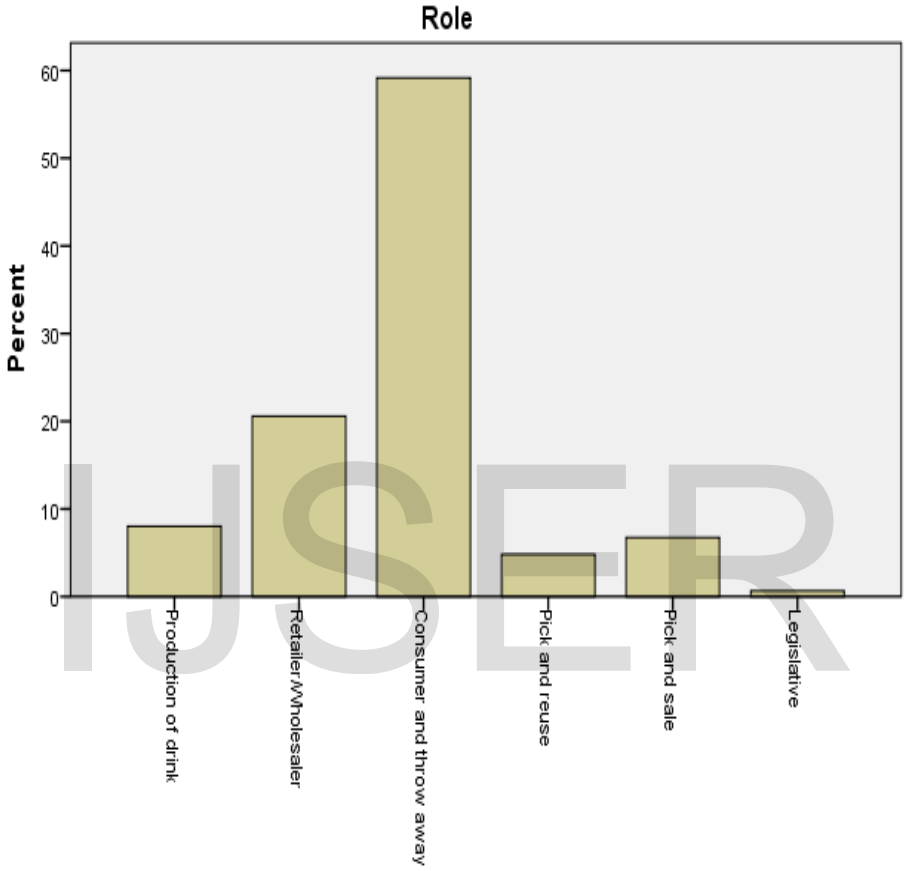

Figure 5: Role in the Cycle of PET bottled Water Scrap (PBWS)

In the Bar Chart above, producers account for 7.4 per cent of respondents, Retailers and Wholesalers 18.9 per cent of respondents, Consumers 58.4 per cent, Pick and reuse or Sale (Scavengers) 14.7 per cent and Legislative/regulatory 0.6 per cent of respondents.

5.2 Test of Hypothesis

The result of the test of hypothesis in table 1 identified and classified the 39 variables into 12 component factors. Component 1 was highly and positively loaded on five factors these are: This system will reduce volume of PBWS (.798), this system will create an avenue of revenue for ESWAMA (.679), This system will reduce littering of PBWS (.672), This system will create an avenue of income (.664), this system will reduce cost of management by ESWAMA (.619). It has the eigen value of 9.873 and

explains 25.316 per cent of acceptance. Component one is therefore an index for measuring the benefits of the developed course of DRS-EPR for managing PBWS in Enugu Urban. The defining variable is reducing the volume of PBWS

Component 2 loaded highly and positively on four factors - Government should introduce sensitization programme to create awareness of the DRS-EPR strategy (.684), ESWAMA should introduce waste to energy plant for plastics (.684) Waste management should be a collective responsibility (.593) Government should declare product stewardship among stakeholders (.521). The eigen value was 2.390 and explained 6.127 per cent acceptance of the developed course. Component 2 is an index measure for recommendation. The defining variable is Government should introduce sensitization programme to create awareness of the DRS-EPR strategy.

Component 3 loaded highly and positively on 3 factors - Only 50% of deposits should be refunded (.833) The remaining 50% should go to producers to off-set administration of PRO'S (.807), Deposit fee should be equivalent to global deposit (.653). It has an eigen value of 1.883 and explains 4.828 of total variance. Component 3 is therefore, an index for measuring Deposit handling. The defining variable is Refunds of 50% of Deposits of returned PBWS.

Component 4 loaded highly and positively on two factors - Retailers should refund consumer deposts (.736) and Producers should refund retailers deposits (.644). It has an eigen value of 1.632 and explains 4.185 of total variance. Component 4 is an index for measuring Deposit collection. The defining variable is Retailers should refund Consumers deposits.

Component 5 loaded highly and positively on two factors - Bar coded plastic bottles made in Enugu will checkmate free-fliers (.758) Bar coded will checkmate counterfeit bottled water produced in Enugu (.713). It has an eigen value of 1.505 and explains a total variance of 3.859. Component 5 is an index for checkmating free-fliers. The defining variable is Bar coded plastic bottles made in Enugu will checkmate free-fliers.

Component 6 loaded highly and positively on one factor and defining variable on charges on PBWS in Enugu – there should be an advanced charge for PBWS produced in Enugu (.681). Component 6 has an eigen value of 1.391 and explains a t total variance of 3.565.

Component 7 loaded heavily and positively on one factor – Government should assign a legal base for the recovery of PBWS (.718). Cmponent 7 has an eigen value of 1.331 and explains a total variance of 3.413.

Component 8 loaded heavily and positively on two factors – this system will make producers improve their product design (.762) and Plastic should be returned to the point of purchase (.527). Component 8

has an eigen value of 1.272 and explains a total variance of 3.262. Component 8 is an index for Producers improving their product design.

Component 9and 10 have factor loadings below 0.5 but have eigen values of 1.189 and 1.070; explaining a total variance of 3.049 and 2.743.

Component 11 loaded hevily and positively on one factor – refund of deposits will motivate post-consumer return of PBWS (.784). Component 11 has an eigen value of 1.054 and explains a total variance of 2.704 and is an index for motivation for returning PBWS.

Component 12 loaded heavily and positively on two factors – the system will incentivize integrated solid waste management (.752) and Producers should set up recovery organizations (.508). Component 12 has an eigen value of 1.002 and a total variance of 2.570. Component 12 is an index to measure Producers compliance to the developed DRS-EPR.

Table 1: The PCA result showing the thirty-nine factors and their loadings

Factors	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
This system will reduce volume of waste	.798	.185	-.018	.061	.027	.100	-.022	-.027	-.061	.007	.016	.078
This system will create an avenue of revenue for ESWAMA	.679	.223	.139	.087	.061	.184	.065	.257	-.034	-.022	.072	-.129
This system will reduce littering of plastic containers	.672	.170	-.085	.101	.104	.019	.080	-.084	-.084	-.139	.160	.320
This system will create an avenue of income	.664	.138	.089	.123	.258	.060	-.184	.243	.272	.070	.058	.069
This system will reduce cost of management by ESWAMA	.619	.006	.027	.126	.194	.076	.240	.290	-.028	-.071	-.011	.151
ESWAMA and scavengers should return collected container	.567	.110	.061	.479	-.025	-.143	.178	-.213	.012	.174	-.080	.027
ESWAMA and scavengers should be refunded	.487	.165	.414	.143	.090	-.235	.285	-.108	.114	.216	-.051	.089

This system can be introduced to other forms of waste streams	.473	.228	.213	.333	-.072	-.077	.161	.320	.346	.046	-.021	.000
This system can be compatible with existing laws	.467	.063	.202	-.056	.106	.408	.334	.072	.213	.087	.038	.042
Plastics not well managed	.449	.356	.092	.042	.139	.070	.188	.062	-.043	-.140	-.021	-.251
Government should introduce sensitization progamme to create awareness	.056	.684	.025	.112	-.019	-.001	.146	.082	-.046	-.062	.085	-.071
ESWAMA should introduce waste to energy plant for plastics	.299	.593	.338	.015	.104	.037	.044	.159	.183	-.085	-.034	.011
Waste management should be acollectiveresponsibility	.353	.578	-.033	.229	.257	.036	-.047	.026	-.059	.106	.100	-.008
Government should declare product stewaedship among stakeholders	.296	.521	.172	.218	.114	.324	.066	.084	.122	.139	.086	.175
ESWAMA should introduce a buy back programme of other plastics	.411	.481	.409	-.100	.106	-.204	.063	.176	-.017	.002	-.027	-.013
Government authorities should formulate recycling club in schools	.410	.476	.128	.145	.152	.163	.239	.143	-.058	.160	.051	.062
Only 50% of deposit should be refunded	.036	.092	.833	-.012	.048	.074	.017	.062	.010	-.043	.144	-.022
Remaining 50% should go to producers	.101	.057	.807	-.004	.147	.162	-.051	-.091	-.143	-.074	.113	.027
Deposit fee should be equivalent to global deposit	-.023	.080	.653	.320	.071	.121	.164	.123	.037	.259	-.042	.047
Retailers should refund consumers	.235	.210	.030	.736	.180	.088	-.014	.008	.144	.116	.046	-.076

Producers should refund deposits	.233	.179	-.058	.644	.145	.252	.172	.209	-.207	.132	.001	.099
Additional deposit will reduce consumption pattern	-.026	.032	.191	.627	.004	.117	.085	.123	-.078	-.404	.230	.092
Producers should pay feeto recover organization	.254	.160	.250	.367	.105	.312	-.235	-.105	.351	.218	.028	.088
Bar coded will disallow plastic containers	.182	.019	.157	.018	.758	-.020	.161	.142	-.018	-.194	.052	-.116
Bar coded will checkmate counterfeits	.083	.300	.016	.216	.713	-.005	.045	.046	.256	.061	-.022	.062
Producers should place a refundable fee	.131	.039	.207	.038	.556	.310	-.049	-.025	-.202	.236	.025	.066
There should be an advance charge	.040	.031	.132	.259	.070	.681	.157	.005	.070	-.056	-.232	.019
Only littered containers should be returned to producers	.320	.099	.246	.053	-.081	.518	.017	-.053	-.106	.217	.385	.047
Government should assign a legal base for recovery of plastics waste	.292	.145	-.048	.147	.087	.080	.718	.024	.102	.157	.157	.072
Unclaimed deposits should remain with producers	.095	.233	.244	.262	.139	.238	.463	-.107	.108	.039	.237	.086
The potential benefitof introducing DRS-EPR outweighs its cost	-.030	.174	.189	-.175	.072	.094	.308	.162	.175	-.198	-.121	.130
This system will make producers improve their product design	.234	.159	-.023	.112	.128	-.074	.087	.762	-.129	.106	-.079	.147
Plastic should be returnedto the point of purchase	.105	.317	.146	.017	.036	.129	-.218	.527	.151	.243	.323	.090
Deposite should be paid by retailers	.043	.028	.116	.029	-.046	-.033	-.147	.058	-.879	-.008	-.069	-.026
There should be penalties for non compliance	-.050	.008	.041	.056	.010	.057	.095	.145	.018	.739	.049	-.025

Refund of deposit will motivate post consumer return	.018	.045	.115	.067	.030	-.062	.099	.013	.045	-.006	.784	-.009
Refund of deposit will motivate separation of containers	.190	.189	.104	.117	.349	-.192	.165	.008	.135	.088	.356	.242
This system will incentivize integrated solid waste management	.111	-.095	.064	-.005	-.056	.079	.123	.211	.017	-.079	.052	.752
Producers should set up recovery organisation	.234	.472	-.066	.171	.297	-.048	-.065	-.171	.082	.179	-.136	.508
Eigen Value	9.873	2.390	1.883	1.632	1.505	1.391	1.331	1.272	1.189	1.070	1.054	1.002
% of Variance	25.316	6.127	4.828	4.185	3.859	3.565	3.413	3.262	3.049	2.743	2.704	2.570
Cumulative Variance	25.316	31.442	36.271	40.456	44.314	47.880	51.292	54.555	57.603	60.346	63.050	65.620

Source: Researchers PCA analysis

6.0 Discussion

The results of the test of hypothesis identified and classified the acceptance of the developed course for DRS-EPR in managing PBWS in Enugu into 10 distinct factors. These are in the descending order of magnitude – benefits of the developed course of DRS-EPR, recommendation, Deposit handling, Deposit collection, checkmating free-fliers, charge for PBWS, Legal base, product design, motivation, and Producers compliance to the developed DRS-EPR.

A breakdown showed that the benefit of the developed DRS-EPR system was more acceptable. It accounted for 25.316 per cent of acceptance of the developed DRS-EPR. It was followed in descending order by recommendation of the system (6.127), Deposit handling (4.828), Deposit collection (4.185), Checkmating free-fliers (3.859), Charge for PBWS (3.565), Legal base (3.413), Product design (3.262), motivation (2.704) and Producers' compliance (2.570).

Table 2: The magnitude of ten identified factors of the developed DRS-EPR for the management of PBWS in Enugu Urban.

Factors	Percentage of Explained Variance
Benefits of the developed DRS-EPR	25.316
Recommendation	6.127

Deposit handling	4.828
Deposit collection	4.185
Checkmating free-fliers	3.859
Charge for PBWS	3.565
Legal base	3.413
Product design	3.262
Motivation	2.704
Producers Compliance	2.570

Source: Researcher's PCA analysis

8. Recommendations

Enugu State and Nigeria in general need to address the effect of PET bottled water scraps by introducing innovative strategy that can manage the scraps and generate revenue to augment waste management cost. Therefore, the government can implement the developed flow of DRS-EPR to manage PBWS. Enugu State Government should introduce sensitization programme to create awareness of the developed DRS-EPR strategy in all institutions, organisations, unions, Manufacturing industries and agencies. Government should declare product stewardship to instigate a collective responsibility. The EPR policy should also be promulgated and enforced. This will not only make producers of PBW responsible for their PBWS, but will also initiate a cost effective, hygienic and revenue generating strategy for managing other forms of wastes in future while achieving Sustainable Development goals on clean water and sanitation and attainment of sustainable cities and communities.

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